

# LM2903/LM2903I, LM393/LM393A, LM293/LM293A

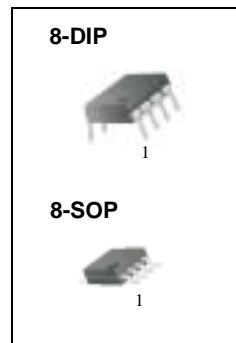
## Dual Differential Comparator

### Features

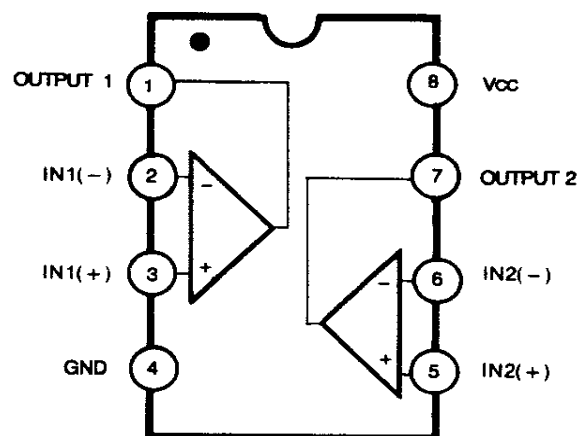
- Single Supply Operation: 2V to 36V
- Dual Supply Operation:  $\pm 1V$  to  $\pm 18V$
- Allow Comparison of Voltages Near Ground Potential
- Low Current Drain 800 $\mu A$  Typ.
- Compatible with all Forms of Logic
- Low Input Bias Current 25nA Typ.
- Low Input Offset Current  $\pm 5nA$  Typ.
- Low Offset Voltage  $\pm 1mV$  Typ.

### Description

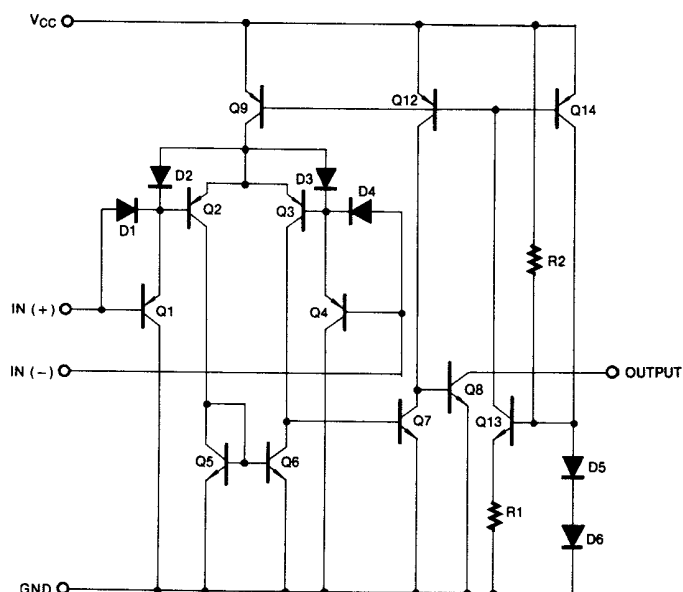
The LM2903/LM2903I, LM393/LM393A, LM293/LM293A consist of two independent voltage comparators designed to operate from a single power supply over a wide voltage range.



### Internal Block Diagram



## Schematic Diagram



## Absolute Maximum Ratings

| Parameter  | Symbol               | Value  | Unit |
|--|----------------------|--|------|
| Power Supply Voltage   | V <sub>CC</sub>      | ±18 or 36  | V    |
| Differential Input Voltage   | V <sub>I(DIFF)</sub> | 36   | V    |
| Input Voltage  | V <sub>I</sub>       | - 0.3 to +36                                     | V    |
| Output Short Circuit to GND  | -                    | Continuous                                       | -    |
| Power Dissipation, T <sub>a</sub> = 25°C<br>8-DIP<br>8-SOP                 | P <sub>D</sub>       | 1040<br>480                                      | mW   |
| Operating Temperature<br>LM393/LM393A<br>LM2903<br>LM2903I<br>LM293/LM293A | T <sub>OPR</sub>     | 0 ~ +70<br>- 40 ~ +85<br>-40 ~ +105<br>-25 ~ +85 | °C   |
| Storage Temperature  | T <sub>STG</sub>     | - 65 ~ +150                                      | °C   |

## Thermal Data

| Parameter  | Symbol           | Value      | Unit |
|--|------------------|------------|------|
| Thermal Resistance Junction-Ambient Max.<br>8-DIP<br>8-SOP | R <sub>θja</sub> | 120<br>260 | °C/W |

## Electrical Characteristics

(VCC = 5V, TA = 25°C, unless otherwise specified)

| Parameter                       | Symbol              | Conditions   | LM293A/LM393A           |      |                       | LM293/LM393 |      |                       | Unit |
|---------------------------------|---------------------|--|-------------------------|------|-----------------------|-------------|------|-----------------------|------|
|                                 |                     |  | Min.                    | Typ. | Max.                  | Min.        | Typ. | Max.                  |      |
| Input Offset Voltage            | V <sub>IO</sub>     | V <sub>O(P)</sub> = 1.4V, R <sub>S</sub> = 0Ω  | -                       | ±1   | ±2                    | -           | ±1   | ±5                    | mV   |
|                                 |                     | V <sub>CM</sub> = 0 to 1.5V   Note 1   | -                       | -    | ±4.0                  | -           | -    | ±9.0                  |      |
| Input Offset Current            | I <sub>IO</sub>     |  | -                       | ±5   | ±50                   | -           | ±5   | ±50                   | nA   |
|                                 |                     | Note 1   | -                       | -    | ±150                  | -           | -    | ±150                  |      |
| Input Bias Current              | I <sub>BIAS</sub>   |  | -                       | 65   | 250                   | -           | 65   | 250                   | nA   |
|                                 |                     | Note 1   | -                       | -    | 400                   | -           | -    | 400                   |      |
| Input Common Mode Voltage Range | V <sub>I(R)</sub>   |  | 0                       | -    | V <sub>CC</sub> - 1.5 | 0           | -    | V <sub>CC</sub> - 1.5 | V    |
|                                 |                     | Note 1   | 0                       | -    | V <sub>CC</sub> - 2   | 0           | -    | V <sub>CC</sub> - 2   |      |
| Supply Current                  | I <sub>CC</sub>     | R <sub>L</sub> = ∞, V <sub>CC</sub> = 5V   | -                       | 0.6  | 1                     | -           | 0.6  | 1                     | mA   |
|                                 |                     | R <sub>L</sub> = ∞, V <sub>CC</sub> = 30V  | -                       | 0.8  | 2.5                   | -           | 0.8  | 2.5                   |      |
| Voltage Gain                    | G <sub>V</sub>      | V <sub>CC</sub> = 15V, R <sub>L</sub> ≥ 15KΩ<br>(for large V <sub>O(P-P)</sub> swing)                        | 50                      | 200  | -                     | 50          | 200  | -                     | V/mV |
| Large Signal Response Time      | T <sub>LRES</sub>   | V <sub>I</sub> = TTL Logic Swing<br>V <sub>REF</sub> = 1.4V, V <sub>RL</sub> = 5V,<br>R <sub>L</sub> = 5.1KΩ | -                       | 350  | -                     | -           | 350  | -                     | nS   |
| Response Time                   | T <sub>RES</sub>    | V <sub>RL</sub> = 5V, R <sub>L</sub> = 5.1KΩ   | -                       | 1.4  | -                     | -           | 1.4  | -                     | μS   |
| Output Sink Current             | I <sub>SINK</sub>   | V <sub>I(-)</sub> ≥ 1V, V <sub>I(+)</sub> = 0V,<br>V <sub>O(P)</sub> ≤ 1.5V                                  | 6                       | 18   | -                     | 6           | 18   | -                     | mA   |
| Output Saturation Voltage       | V <sub>SAT</sub>    | V <sub>I(-)</sub> ≥ 1V, V <sub>I(+)</sub> = 0V   | -                       | 160  | 400                   | -           | 160  | 400                   | mV   |
|                                 |                     | I <sub>SINK</sub> = 4mA   Note 1   | -                       | -    | 700                   | -           | -    | 700                   |      |
| Output Leakage Current          | I <sub>O(LKG)</sub> | V <sub>I(-)</sub> = 0V,<br>V <sub>I(+)</sub> = 1V  | V <sub>O(P)</sub> = 5V  | -    | 0.1                   | -           | -    | 0.1                   | nA   |
|                                 |                     |  | V <sub>O(P)</sub> = 30V | -    | -                     | 1.0         | -    | -                     | 1.0  |

### NOTE 1

LM393/LM393A: 0 ≤ T<sub>A</sub> ≤ +70°C

LM2903: -40 ≤ T<sub>A</sub> ≤ +85°C

LM2903I: -40 ≤ T<sub>A</sub> ≤ +105°C

LM293/LM293A: -25 ≤ T<sub>A</sub> ≤ +85°C

**Electrical Characteristics** (Continued)

(VCC = 5V, TA = 25°C, unless otherwise specified)

| Parameter                       | Symbol              | Conditions   | LM2903/LM2903I |      |                         | Unit |
|---------------------------------|---------------------|--|----------------|------|-------------------------|------|
|                                 |                     |  | Min.           | Typ. | Max.                    |      |
| Input Offset Voltage            | V <sub>IO</sub>     | V <sub>O(P)</sub> = 1.4V, R <sub>S</sub> = 0Ω  | -              | ±1   | ±7                      | mV   |
|                                 |                     | V <sub>CM</sub> = 0 to 1.5V   Note 1   | -              | ±9   | ±15                     |      |
| Input Offset Current            | I <sub>IO</sub>     |  | -              | ±5   | ±50                     | nA   |
|                                 |                     | Note 1   | -              | ±50  | ±200                    |      |
| Input Bias Current              | I <sub>BIAS</sub>   |  | -              | 65   | 250                     | nA   |
|                                 |                     | Note 1   | -              | -    | 500                     |      |
| Input Common Mode Voltage Range | V <sub>I(R)</sub>   |  | 0              | -    | V <sub>CC</sub><br>-1.5 | V    |
|                                 |                     | Note 1   | 0              | -    | V <sub>CC</sub> -2      |      |
| Supply Current                  | I <sub>CC</sub>     | R <sub>L</sub> = ∞, V <sub>CC</sub> = 5V   | -              | 0.6  | 1                       | mA   |
|                                 |                     | R <sub>L</sub> = ∞, V <sub>CC</sub> = 30V  | -              | 1    | 2.5                     |      |
| Voltage Gain                    | G <sub>V</sub>      | V <sub>CC</sub> = 15V, R <sub>L</sub> ≥ 15KΩ<br>(for large V <sub>O(P-P)</sub> swing)                      | 25             | 100  | -                       | V/mV |
| Large Signal Response Time      | T <sub>LRES</sub>   | V <sub>I</sub> = TTL Logic Swing<br>V <sub>REF</sub> = 1.4V, V <sub>R</sub> L = 5V, R <sub>L</sub> = 5.1KΩ | -              | 350  | -                       | nS   |
| Response Time                   | T <sub>RES</sub>    | V <sub>R</sub> L = 5V, R <sub>L</sub> = 5.1KΩ  | -              | 1.5  | -                       | μS   |
| Output Sink Current             | I <sub>SINK</sub>   | V <sub>I(-)</sub> ≥ 1V, V <sub>I(+)</sub> = 0V, V <sub>O(P)</sub> ≤ 1.5V                                   | 6              | 16   | -                       | mA   |
| Output Saturation Voltage       | V <sub>SAT</sub>    | V <sub>I(-)</sub> ≥ 1V, V <sub>I(+)</sub> = 0V   | -              | 160  | 400                     | mV   |
|                                 |                     | I <sub>SINK</sub> = 4mA   Note 1   | -              | -    | 700                     |      |
| Output Leakage Current          | I <sub>O(LKG)</sub> | V <sub>I(-)</sub> = 0V, V <sub>O(P)</sub> = 5V   | -              | 0.1  | -                       | nA   |
|                                 |                     | V <sub>I(+)</sub> = 1V, V <sub>O(P)</sub> = 30V  | -              | -    | 1.0                     | μA   |

**Note 1**

LM393/LM393A: 0 ≤ TA ≤ +70°C

LM2903: -40 ≤ TA ≤ +85°C

LM2903I: -40 ≤ TA ≤ +105°C

LM293/LM293A : -25 ≤ TA ≤ +85°C

# Typical Performance Characteristics

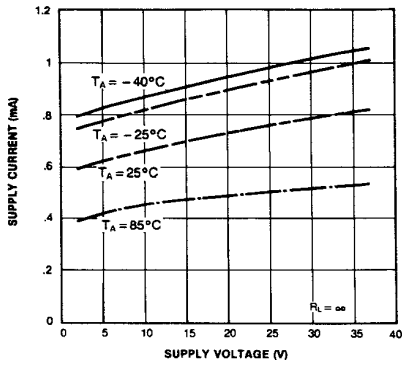


Figure 1. Supply Current vs Supply Voltage

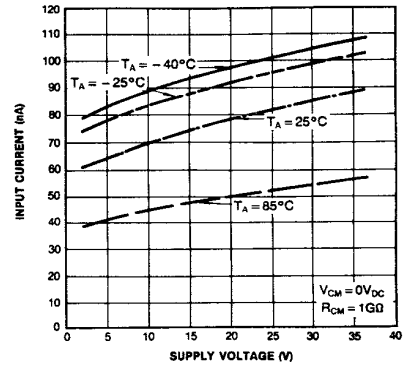


Figure 2. Input Current vs Supply Voltage

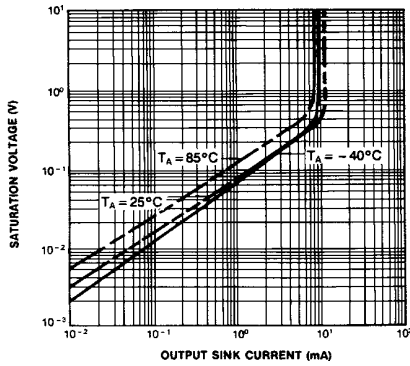


Figure 3. Output Saturation Voltage vs Sink Current

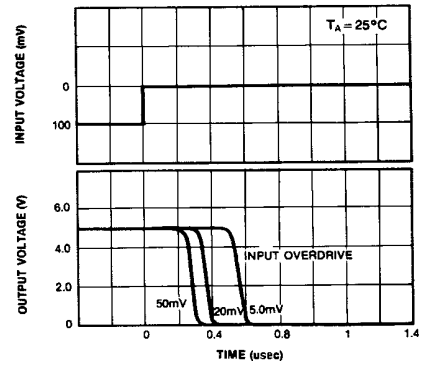


Figure 4. Response Time for Various Input Overdrive-Negative Transition

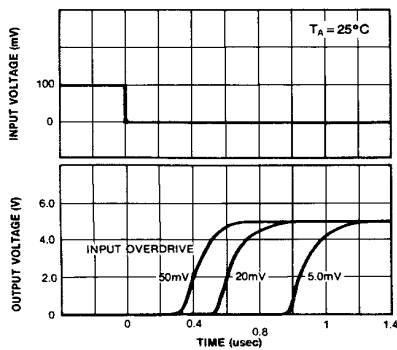


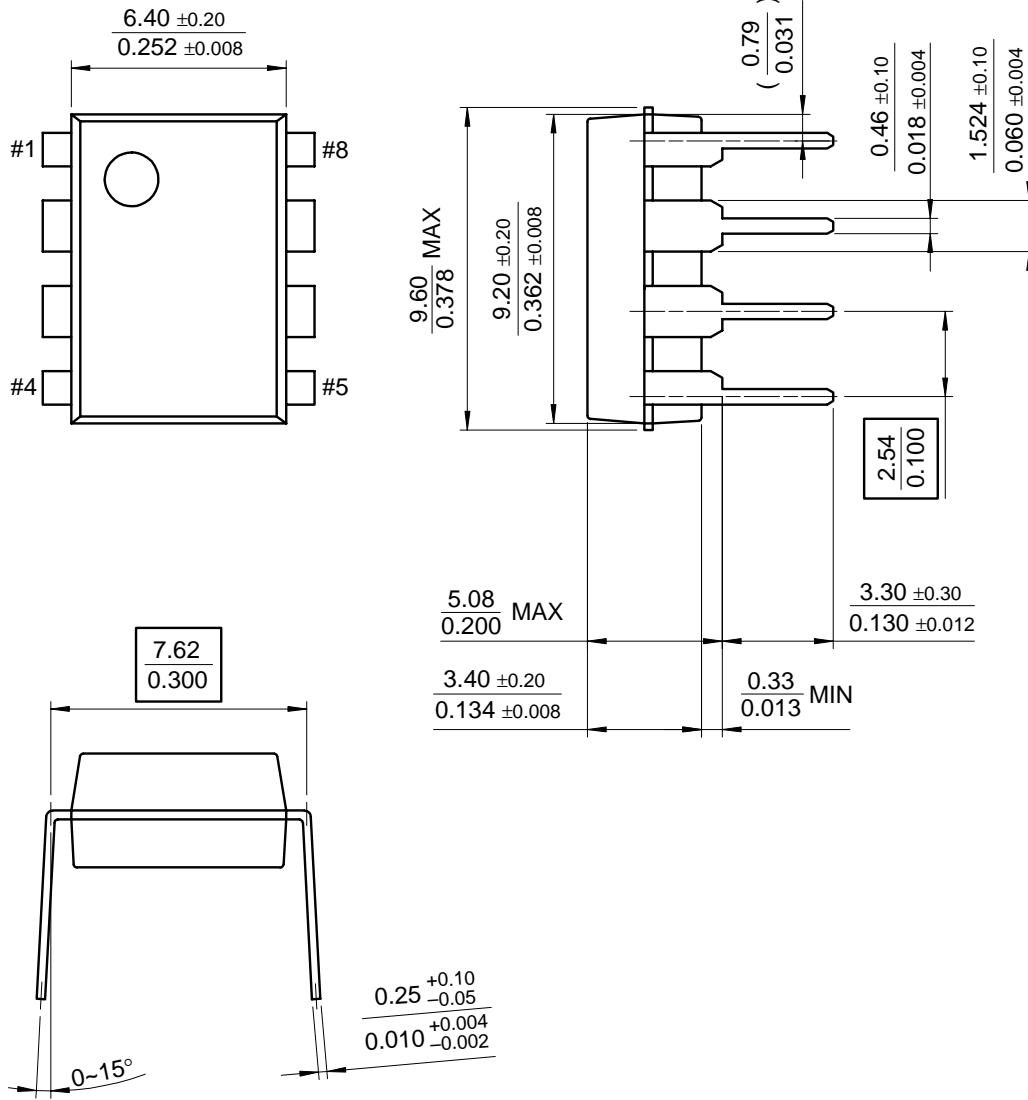
Figure 5. Response Time for Various Input Overdrive-Positive Transition

# Mechanical Dimensions

## Package

Dimensions in millimeters

### 8-DIP

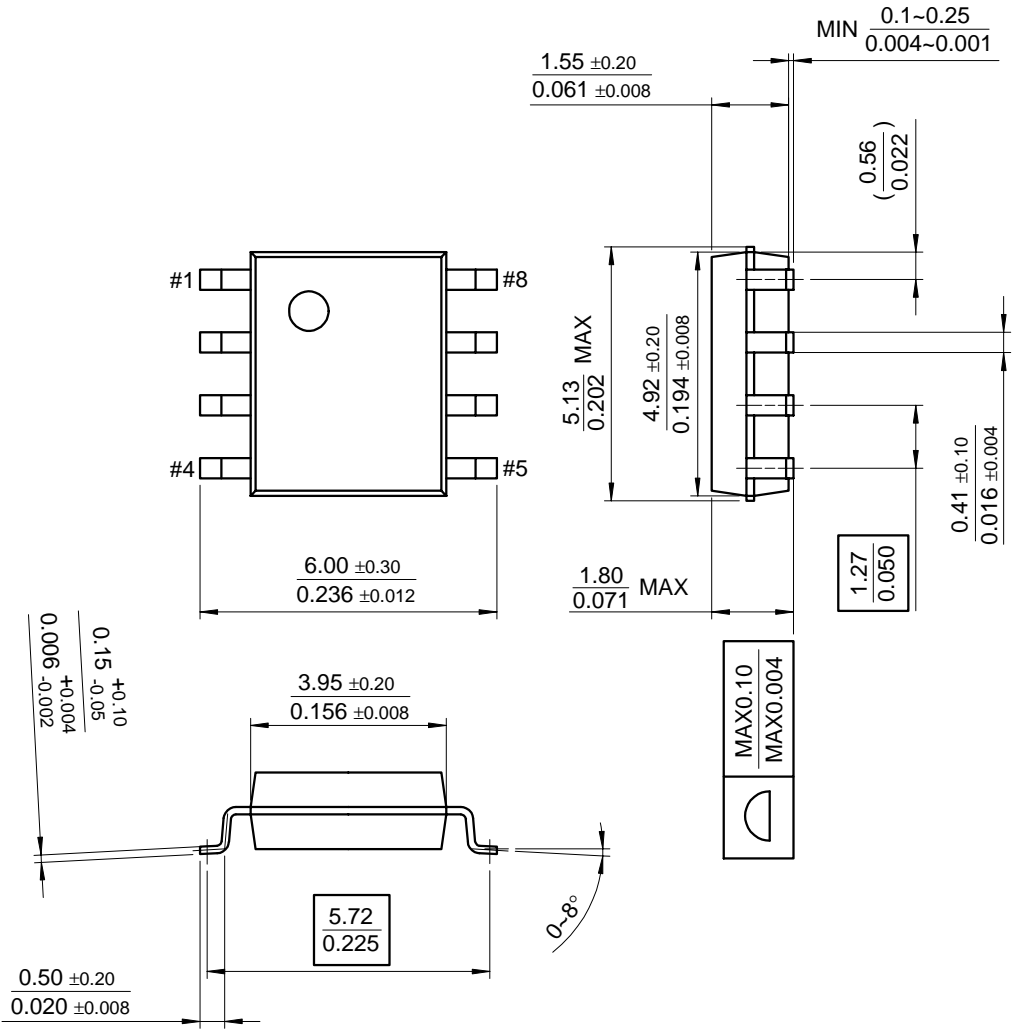


**Mechanical Dimensions** (Continued)

Package

Dimensions in millimeters

**8-SOP**



## Ordering Information

| Product Number | Package | Operating Temperature |
|----------------|---------|-----------------------|
| LM393N         | 8-DIP   | 0 ~ + 70°C            |
| LM393AN        |         |                       |
| LM393M         | 8-SOP   |                       |
| LM393AM        |         |                       |
| LM2903N        | 8-DIP   | -40 ~ + 85°C          |
| LM2903M        | 8-SOP   |                       |
| LM2903IN       | 8-DIP   | -40 ~ + 105°C         |
| LM2903IM       | 8-SOP   |                       |
| LM293N         | 8-DIP   | -25 ~ + 85°C          |
| LM293AN        |         |                       |
| LM293M         | 8-SOP   |                       |
| LM293AM        |         |                       |

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